Potentiality of 'Biofuel Co-products' as Novel Alternatives to Energy and Protein Feeds for Livestock and Poultry

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ABSTRACT

The energy and protein are the major nutrients need to be supplied at sufficient levels for optimum productive and reproductive performances of livestock. Day-to-day increasing prices of energy and protein feed ingredients have been significantly affecting profitability of livestock enterprises for feeding being the major expense. Searching for alternatives is one of the viable options to curtail feeding cost in livestock enterprises. With the growing biofuel industries, their byproducts may be potential alternatives to conventional energy and protein feed ingredients for livestock. Exploiting biofuel co-products based on nutritional and anti-nutritional components and finding out suitable feeding level will help to address feed shortage optimizing livestock productivity and economic sustainability.

INTRODUCTION

The livestock and poultry sector play pivotal role in supporting livelihood of people, particularly the rural communities, significantly contributing to socio-economic and nutritional well-being and economic growth of the country. With 536.76 million livestock and 851.81 million poultry population (Livestock Census, 2019), India ranks 1st in milk production contributing 24.76% of global production, 2nd in egg and 5th in meat production globally (FAO, 2022). Livestock sector provides employment to nearly 8.8 % of the population in India.

Amongst many challenges of the livestock and poultry industries across the country, deficits of feeds and fodders is one of the factors significantly affecting productivity and production cost narrowing the profit margin for the entrepreneurs. There are deficits of nearly 30% of concentrates, 23% dry fodders and 11% green fodders of the total requirements in the country. Feeding cost, being the major expenses of livestock and poultry enterprises, accounting to 60-70% of the total production cost, contributes significantly to the profit margin. Unless feeding cost cannot be reduced, farmers cannot expect remunerative profit for their produces. The prices of the feed ingredients are increasing day-by-day for their ever-increasing demands with the increasing animal population. On the other hand, there is shrinkage of cultivable lands in a steady pace for population growth, industrialization and urbanization. In such a scenario, it has become imperative for the farmers to search for alternatives to the conventional feed ingredients. In this regards, locally available unconventional feed resources are becoming valuable for not only to curtail feeding cost for livestock enterprises, but also to assure remunerative and sustainable profit for the livestock enterprises.

Amongst many unconventional feed-stuffs explored in various corners of the country, wastes/by-products generated by bioethanol/biodiesel production industries have been emerging as valuable novel feeds for the livestock and poultry species. These wastes/by-products may safely be utilized as substitutes of energy and protein feed ingredients for livestock and poultry. Distiller grains, dried distiller grains with solubles (DDGS), glycerin, fatty acid distillates, meals of camelina, brassica and jatropha etc. are some of the novel alternate feeds generated as co-products in bioethanol and biodiesel production industries. These ingredients contain considerable amounts of energy in the form of starch and proteins along with many other essential nutrients.

Biofuel co-products as animal feeds

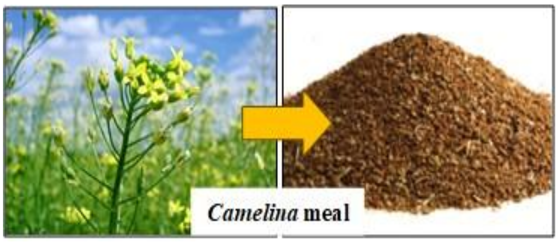
The dried distiller grains with solubles (DDGS) can be fed to both livestock and poultry. It is produced as by-products of grain ethanol production. The production of DDGS is increasing in recent years with the increasing demands for bioethanol as transportation fuel. The ground grain is first mixed with water and then enzyme is added to break down the starch into glucose. It is then fermented by adding yeast cells to convert sugar into alcohol. Then the alcohol (ethanol) is separated and the non-volatile components are centrifuged again to further separate solid fraction (wet cake) from liquid fraction (stillage). The liquid fraction is evaporated and the remaining solid fraction is called the DDGS. It is primarily used as alternate feeds for dairy and swine. However, there are many reports of utilizing DDGS at various levels for different categories of pigs and poultry (Makkar, 2018). The nutrient content of DDGS varies depending on grain types i.e. maize, wheat, barley or sorghum. The crude protein, rumen undegradable protein, ether extract and total ash percentage of DDGS (maize, wheat, barley, sorghum) on dry matter basis varies from 15-36, 37-55%, 6-11% and 3-5% (Schingoethe *et al*., 2006). It is also good source of calcium, phosphorous and sulphur. DDGS can be utilized as alternative to maize grain and soyabean meal in the diets of cattle, pigs, poultry and fish. However, there may be some undesirable factors in DDGS which may adversely affect health and

productivity of animals and birds. Such factors include mycotoxins, non-starch polysaccharides (NSP), phytate and antibiotics. Therefore, while incorporating DDGS in livestock rations, every precaution must be taken not to exceed the recommended level of incorporation as specified by nutritionists from various corners of the world.

With the increasing demand for biodiesel production, there is simultaneous increase in the availability of glycerin, which is a sweet-tasting liquid with energy similar to maize (Groesbeck *et al*., 2008). This co-product can be marketed either in crude (high content of fatty acids) or semi-purified (low fatty acid content) form (Carvalho *et al*., 2013). Neutralized semi-purified glycerin (NSPG) is the byproduct of bio-diesel production. It is the end product during the acidification process of crude glycerol in biodiesel production process to remove the fatty acids and salts. Neutralization is done with the help of an alkali (sodium hydroxide) to bring the pH to a neutral level. This process yields a product with lower methanol content and higher concentration of salts and minerals making it suitable as animal feed. NSPG can be used as alternative to conventional energy feed in swine ration. NSPG contains 11.89% moisture, 80.20% glycerol, 0.90% crude protein, 3.535 kcal GE/kg, <0.10% fats, 6.18% total ash, 92.18 ppm calcium, 158.52 ppm phosphorous, 0.42% potassium, 3.52% sodium, 2.34% chloride, 45.13 ppm magnesium, 0.24 ppm copper, 23.72 ppm iron, 0.39 ppm zinc, 0.80 ppm manganese, and 0.83 ppm cobalt (Diaz-Huepa *et al*., 2015). As reported by Gallego *et al*. (2016), NSPG can safely be added in the diets of growing and finishing pigs up to 14% level. Glycerin can be incorporated up to 18% in the diet of nursery pigs without affecting nutrient digestibility and blood metabolites (Oliveria *et al*., 2014). NSPG can also be incorporated up to 12% in the diets of piglets (6-15 kg) without impairing the plasmatic variables, performance, and economic feasibility (Diaz-Huepa *et al*., 2015).

Animals can also utilize meals of unconventional oil seeds like camelina and brassica species, palm and jatropha as alternatives to conventional oil seed cakes.

Camelina sativa is a member of the family *Brassicaceae* (Gehringer *et al*., 2006) and is a valuable oil seed crop for biofuels and bio lubricants production. It can be grown on marginal lands (Gesch and Archer, 2013).



Camelina meal is obtained as byproduct after extraction of oil from camelina seeds. It contains 45-50% protein, 10-15% residual oil, and various nutrients including fiber, minerals, and vitamins. The cold-pressed camelina meal contains 35-40 percent crude protein, 6-12 percent fat, 6-7 percent ash, and 41 percent neutral-detergent fibre and gross energy - 4600–4800 kcal/kg. Solvent extracted *Camelina sativa* meal contains 3.52% fat and 41.04% crude protein (Delever and Smith, 2024). It can be used as a cost-effective source of protein and lipids in livestock feeds. For high protein level, it can be utilized efficiently as alternative to soybean meal in the rations of animals and birds. However, for its glucosinolate content, it is required to be processed (like toasting) before feeding to the animals to reduce its content. *Camelina sativa* meal can be incorporated up to 10% level in the ration of layer birds. *Camelina sativa* expeller cake can be included up to 30% level in pig rations depending on its glucosinolate content. Dietary inclusion of *Camelina* meal at 10% level can significantly reduce lipid oxidation and improves γ-tocopherol content and antioxidant activity in the dark meat.

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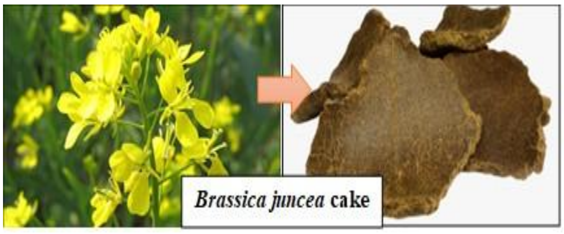
Feeding *Camelina* meal also increases omega-3 fatty acids and tocopherols in eggs and meat.

Brassica juncea cake and detoxified *Jatropha curcas* kernal meal can be included up to 18% level in pigs and up to 50% level as replacement of protein from conventional protein source in the ration of pigs. The *B. juncea* meal contains protein (417 g/kg DM), ether extract (28 g/kg), metabolisable energy (7.9 MJ/kg) and dietary fibre (277 g/kg DM). However, it contains glucosinolates (16.7 µmol/g) which can be removed by application of processing method like extrusion (Radfar *et al*., 2017) and thereby its nutrient digestibility can be increased and will be suitable for feeding to pigs and poultry as replacement of conventional oil cakes. It had been reported that incorporation of *B. juncea* oil meal up to 225 g/kg in concentrates did not affect intake, digestion, or fermentation, but it improved milk yield and nitrogen utilization in goat (Durge *et al*., 2014). In layer, juncea cake can support acceptable laying performance, but it reduces digestibility of nutrients. In broilers, enzyme can be supplemented to improve the energy value and feed conversion ratio when *B. juncea* meal is incorporated (Oryschak *et al*., 2020).


Brassica juncea cake

The detoxified *Jatropha curcas* kernel meal (DJKM) is a valuable unconventional protein feed ingredient for livestock and poultry. It contains 67.8% crude protein on a dry matter basis, which is equivalent to fish meal, making it an excellent source of protein. The amino acid composition of *Jatropha* kernel meal is similar to soyabean meal, except lysine which is lower. But, the sulphur-containing amino acids cystine and methionine levels are higher in *Jatropha* kernel meal than the soyabean meal. However, its use is constrained for the presence of anti-nutritional factor 'phorbol esters. Simple processing methods like soaking in water, boiling and sun-drying and heat treatment may be employed to reduce the level of phorbol esters to acceptable level. Detoxified JKM can be fed as substitute of soyabean meal up to 50% level without negatively affecting growth, meat quality or animal health in pigs and turkeys (Berenchtein *et. al*., 2014). There is also recommendation of 30% replacement of soyabean meal with DJKM in growing pigs with tolerance level of phorbol esters to the extent of 5.5 mg/kg diet in growing pigs (Li *et al*., 2015). The phytate level of *Jatropha* kernels meal is nearly 9% which is higher than level found in conventional oil cakes. Therefore, supplementation of phytase enzyme is indicated.


Jatropha curcas kernel meal

CONCLUSION:

Precision feeding management has direct influence on sustainability of animal enterprises. Feeding being the major expenditure in animal farming, curtailing feeding cost by substituting the conventional feed ingredients with suitable alternatives can improve productivity and profitability of animal enterprises.

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